Space Weather Technical Forecast

Issued on Wednesday, 29 December 2021 at 00:37 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Slight chance of G1/Minor Geomagnetic storms. Chance of R1 radio blackouts.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate over the past 24 hours, with two M-class X-ray flares observed at GOES 16 from AR2918, plus several C-class flares.
There are currently six active regions on the solar disc, including one as yet unnumbered in the southwestern quadrant. AR2921 in the northwest has developed into a Eso/ Beta and 2916 near the centre remains the largest region (Ehi/Beta) but neither has produced any noteworthy flares. However, 2918 in the northwest produced two M-class flares, the largest of which was an M1.89 at 28/0401UTC. The other three regions are weak and stable.

No Earth-directed Coronal Mass Ejections (CMEs) were observed in available imagery during the period. Though there appeared to be a weak slow CME from the M1.89 flare, analysis has proven to be difficult but this CME is not thought to be Earth-directed.

Solar Wind / Geomagnetic Activity: The solar wind, as observed by DSCOVR at L1, has fluctuated between elevated levels and slightly-elevated. Peaking around 540km/s but also dipping back to just above 400 km/s at times. It was predominantly in the 450-470km/s bracket. These speeds are probably as a result of a connection to CH37/+, a southern extension of the northern crown. The solar wind density was average or just above average. The IMF started at Moderate levels around 10nT before easing to weak levels below 5nT towards the end of the period, with the north-south component varying between +5/-8nT. Finally, the phi angle was mostly positive (away from the sun).The net result of the above solar wind measures was provisionally mainly Unsettled (Kp3), before easing to Quiet (Kp1-2) for much of the period.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) remained at Background levels. The high energy electron flux (greater than 2 MeV) was at Normal Background levels. The fluence drifted lower through in the period with observed fluence at 29/0000UTC being 5.97e6 integrated pfu.

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Four-Day Space Weather Forecast Summary

Solar Activity: Low to Moderate solar activity is forecast to continue throughout the period with further isolated M-class flares, most likely from AR2916 and AR2918. No significant regions are anticipated to emerge from the far-side onto the sun in the period.

Solar Wind / Geomagnetic Activity: Initially Earth is likely to fall under Coronal Hole influences with fast winds from either CH38/+ or CH39/+. Also, Earth may experience a glancing blow from a CME on day 2 (Thursday 30 December). Winds may ease back on day 3 (31st) but on day 4 (1st Jan) a fast wind from CH40 may arrive later in the day. Through the period geomagnetic activity is likely to be Quiet to Unsettled with a chance of Active intervals and a slight chance (20%) of G1 minor geomagnetic storms.

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is expected to remain at Background levels, albeit with a daily Slight Chance of S1 should there be any significant flare activity. High energy electron flux (greater than 2MeV) levels are relatively uncertain, but may recover to track near the Active threshold during the diurnal maximum, most likely days 2-4 (30th-1st). Fluence levels are expected to remain below the 1e8 warning threshold, has forecast by MOSWOC REF Model.

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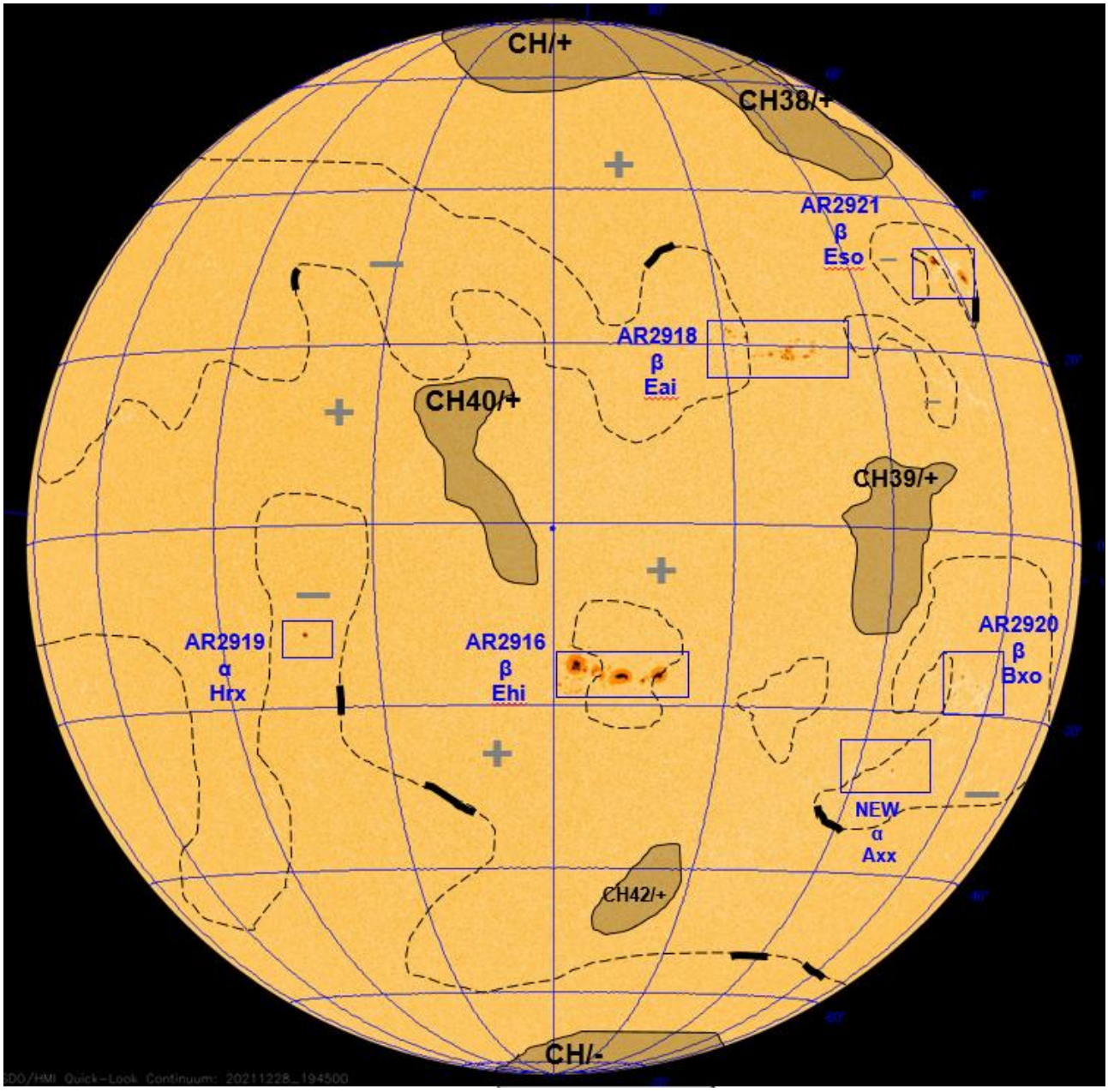
Figure 1. Solar Analysis Valid 28/2000UTC.



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Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

The coronal hole forecast for the period is of low confidence due to lack of similarity of the current disc with the previous rotation, but also the apparent dissimilarity of current conditions with those seen at STEREO A around 3 days upwind of Earth. Specifically, the current coronal hole enhancement, perhaps from CH38/+, is not especially obvious in MAG and PLASTIC data for the relevant period, with a more obvious spike due early day 1 (Wednesday 29 December), with this thought to emanate from CH39/+. This could provide the peak risk (20%) of geomagnetic storm intervals in the period. Winds may ease on day 3 (31st) however, during day 4 (1st Jan), there appears to be a more assured high speed stream from a persistent coronal hole, numbered CH40/+.

There is a small chance on day 2 (Thursday 30 December) of peripheral effects from a glancing blow from a filament eruption which occurred 26/2012UTC. This is currently forecast to most likely miss Earth, but again confidence is low given some MOSWOC Enlil ensemble members have glancing blows of Earth. No other CMEs feature in the current forecast.
So through the period geomagnetic activity is forecast to be Quiet to Unsettled, with a chance of Active intervals and a slight chance of a G1 Minor Geomagnetic storm.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	20	20	20	20
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
27/0418 UTC	N/A	Filament eruption	SW quadrant	500km/s	Probable miss. Minority Enlil ensemble members suggest later on Thursday 30 Dec UTC day.	Small chance of glancing blow

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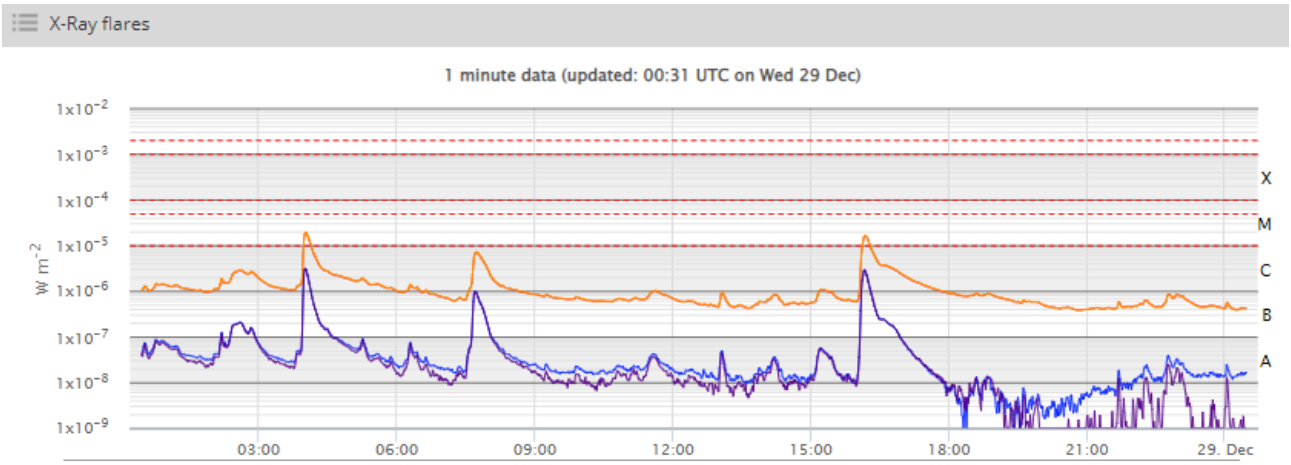
Radio Blackouts - X-Ray Flares:

Solar Activity has been Low to Moderate, with two M-class flares observed on the 28th along with a number of small C-flares. Background X-ray flux recorded at GOES 16 continued to show an overall slight decline. The current Earth-facing disc is dominated by AR2916 and AR2918, although neither of these regions has delivered the full potential for their classification, being Ehi/Beta and Eai/Beta respectively.

In terms of overall trends, no major returning regions are forecast over the eastern limb in the coming four-day period. This may give a relatively flat X-ray flare tendency. Solar activity is likely to continue Low, with further C-class flares. There is a daily Chance of activity increasing to Moderate levels, with further isolated M-class flares. These are most likely to come from active regions 2916 and 2918 during days 1 and 2 (29th and 30th).

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 M Class	No	50	50	30	30
Very Active	R3 to R5 X Class	No	5	5	1	1

Figure 2: X-Ray flares at GOES16, shows to low M-class flares on the 28th Dec.



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Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) as observed by GOES-16 is currently at Background levels and will most likely persist as such. There is a Slight Chance of S1 from any notable flares on the disc, perhaps most likely from AR2916 or AR2918 as they rotate further westwards across the western hemisphere.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	5	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

The Electron Flux levels were at normal background levels through the 28th Dec UTC day.
Some increase can be expected over the next 4 days with an increasing likelihood each day that Flux levels may exceed the 1000pfu alert level during the diurnal maximum.
Fluence levels are expected to remain below the 1e8 integrated pfu warning level, though this forecast in relatively low confidence given the marked differences with the solar disk now compared to previous rotations. Also the collapse in Flux values observed on the 28th was dramatic and a little unexpected, though it remains unlikely that we will see an equally dramatic increase in levels.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	5	10	20	20
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 3: Fluence levels are expected to remain below 1e8 integrated pfu.

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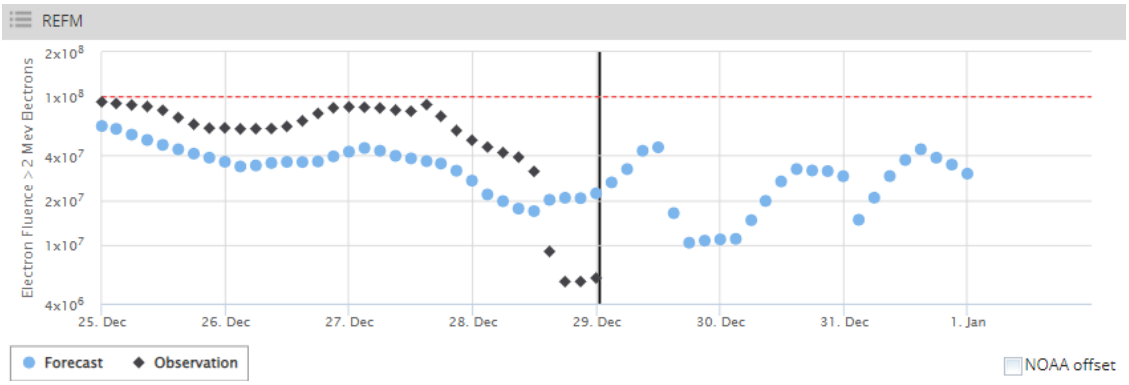

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